

**Appendix G**  
**TRUs for Each**  
**Contaminant/Functional**  
**Group**

## **Appendix G**

### **Toxicity Reference Values and Bioaccumulation Factors for Each Contaminant/Functional Group**

**Table G-1.** PUFs and BAFs for WAG 9 nonradionuclide contaminants (unitless).

	BAF <sup>a</sup> for herbivores	BAF <sup>b</sup> for insectivores	BAF <sup>c</sup> for carnivores	BAF <sup>d</sup> for omnivores
<b>Inorganics<sup>e</sup></b>				
Aluminum	1.0E+00	1.0E+00	4.0E-03	1.0E+00
Antimony	1.0E+00	1.0E+00	6.0E-03	9.0E-01
Arsenic	1.0E+00	1.0E+00	4.0E-02	1.0E+00
Barium	1.0E+00	1.0E+00	1.5E-02	1.0E+00
Beryllium	1.0E+00	1.0E+00	1.0E-02	1.0E+00
Cadmium	1.0E+00	1.1E+00	1.9E+00	1.9E+00
Chloride	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Chromium	1.0E+00	6.0E-02	2.0E-01	2.0E-01
Cobalt	1.0E+00	1.0E+00	2.0E-02	1.0E+00
Copper	1.0E+00	1.0E+00	2.0E-01	1.0E+00
Fluoride	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Cyanide	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Lead	1.0E+00	3.0E-01	6.0E-01	6.0E-01
Magnesium	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Manganese	1.0E+00	1.0E+00	2.5E-01	1.0E+00
Mercury	1.0E+00	4.0E-01	7.0E-01	7.0E-01
Nickel	1.0E+00	1.0E+00	6.0E-03	1.0E+00
Selenium	1.0E+00	1.0E+00	2.5E-02	1.0E+00
Silver	1.0E+00	1.0E+00	4.0E-01	1.0E+00
Sodium	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Sulfate	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Thallium	1.0E+00	1.0E+00	4.0E-03	1.0E+00
Vanadium	1.0E+00	1.0E+00	5.5E-03	1.0E+00
Zinc	1.0E+00	1.0E+00	7.0E-01	1.0E+00
<b>Organics<sup>f</sup></b>				
PCBs	1.0E+00	1.3E-03	1.3E-03	1.3E-03
TCDD <sup>g</sup>	1.0E+00	1.0E+00	1.0E+00	1.0E+00

a. BAFs for herbivores, appropriate for use with AV100 and M100 Functional Groups. Includes the trumpeter swan and pygmy rabbit.

b. BAFs for insectivores, appropriate for AV200 and M200 Functional Groups. Includes the black tern, white-faced ibis, Townsend's big-eared bat, small-footed myotis, and long-eared myotis.

c. BAFs for carnivores, appropriate for AV300 and M300 Functional Groups. Includes the northern goshawk, peregrine falcon, bald eagle, ferruginous hawk, loggerhead shrike, and burrowing owl.

d. BAFs for omnivores, appropriate for AV400 and M400 Functional Groups.

e. Values and or literature (Appendix H) for inorganics come from Baes et al., (1984).

f. Values for organics come from allometric equations presented in Travis and Arms (1988).

g. PUF and BAFs calculated for TCDD, were used for HpCDD, OCDD, and PeCDD.

Table G-2. Summary of toxicity reference values (TRVs in mg/kg-day) for mammalian functional groups.

Chemical	TRV for M121	TRV for M122	TRV <sup>a</sup> for M122A	TRV for M123	TRV for M210	TRV <sup>b</sup> for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
2,3,7,8-tetrachlorodibenzo-p-dioxin (Rat-NOAEL) <sup>c</sup>	3.3E-7	3.3E-7	3.3E-7	3.3E-7	3.3E-7	3.3E-7	3.3E-7	3.3E-7	5E-7	5E-7
Aluminum (Cow-NOAEL)	1.28	1.28	1.28	1.28	2.18	2.18	2.18	2.18	3.26	3.26
Aluminum (Rabbit-NOAEL)	0.0081	0.0081	0.0081	0.0081	0.0054	0.0054	0.0054	0.0054	0.0054	0.0054
Aluminum (Rat-TDL)	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.18	3.26	3.26
Aluminum (Rat-AEL)	2.38	2.38	2.38	2.38	2.38	2.38	2.38	2.38	3.57	3.57
Antimony (Mouse)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.35	0.35
Arsenic (Dog-NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.32
Arsenic (Mouse-LOAEL)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.08	0.08
Arsenic (Rat-NOAEL)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.19	0.19
Arsenic (Sheep-NOAEL)	0.064	0.064	0.064	0.064	0.043	0.043	0.043	0.043	0.043	0.043
Arsenic (Sheep-NOAEL)	0.097	0.097	0.097	0.097	0.064	0.064	0.064	0.064	0.064	0.064
Barium (Rat-NOAEL)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.05
Barium (Dog-FEL-F)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.36	0.73
Beryllium (Rat-NOAEL)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.33	0.33
Cadmium (Rat-LOAEL)	8.0E-04	8.0E-04	8.0E-04	8.0E-04	8.0E-04	8.0E-04	8.0E-04	8.0E-04	1.0E-03	1.0E-03

Chemical	TRV for M121	TRV for M122	TRV <sup>a</sup> for M122A	TRV for M123	TRV for M210	TRV <sup>b</sup> for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Chloride (Mouse -LD50)	2.94	2.94	2.94	2.94	2.94	2.94	2.94	2.94	4.41	4.41
Chromium (III) (Rat -NOAEL)	250	250	250	250	250	250	250	250	375	375
Chromium (VI) (Dog -NOAEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.15
Chromium (VI) (Mouse -FEL)	3.28	3.28	3.28	3.28	3.28	3.28	3.28	3.28	4.92	4.92
Cobalt (Dog -LOAEL)	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	2.08	4.17
Cobalt (Rat -NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.21
Copper (Mink -NOAEL)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	1.95	0.65	0.65
Copper (Rat -NOAEL)	1.83	1.83	1.83	1.83	1.8	1.83	1.83	1.83	2.75	2.75
Cyanide (Pig -LOAEL)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.39	0.39
Cyanide (Rat -NOAEL)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.7	2.7
Fluoride (Mink -NOAEL)	10.46	10.46	10.46	10.46	10.46	10.46	10.46	31.37	10.46	10.46
Lead (Cattle -NOAEL)	0.038	0.038	0.038	0.038	0.025	0.025	0.025	0.025	0.025	0.025
Lead (Dog -NOAEL)	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	1.6	3.3
Lead (Dog -LOAEL)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.009	0.018
Lead (Rat -LOAEL)	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.09	0.09
Lead (Rat -LOAEL)	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	4	4
Magnesium (Sheep -NOAEL)	1.06	1.06	1.06	1.06	0.71	0.71	0.71	0.71	0.71	0.71
Manganese (Rat -LOAEL)	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	6.5	6.5
Mercury (Organic) (Cow -NOAEL)	0.0028	0.0028	0.0028	0.0028	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019

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Chemical	TRV for M121	TRV for M122	TRV <sup>a</sup> for M122A	TRV for M123	TRV for M210	TRV <sup>b</sup> for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Mercury (Organic) (Mink- NOAEL)	0.0094	0.0094	0.0094	0.0094	0.0063	0.0063	0.0063	0.0063	0.0063	0.0063
Mercury (Inorganic) (Mouse -NOAEL)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.09	0.09
Mercury (Inorganic) (Mouse -NOAEL)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Mercury (Inorganic) (Swine -NOAEL)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.031	0.031
Mercury (Organic) (Swine -NOAEL)	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0031	0.0031
Mercury (Rat -NOAEL)	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0125	0.0125
Mercury (Rat -NOAEL)	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0125	0.0125
Mercury (Deer -LD50)	0.11	0.11	0.11	0.11	0.07	0.07	0.07	0.07	0.07	0.07
Mercury (Cat -NOAEL)	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0025
Nickel (Cow -NOAEL)	0.11	0.11	0.11	0.11	0.08	0.08	0.08	0.08	0.08	0.08
Nickel (Dog -NOAEL)	4.17	4.17	4.17	4.17	4.17	4.17	4.17	4.17	6.25	12.50
Nickel (Rat -NOAEL)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	1.25	1.25
PCBs - Aroclor 1260 (Rat -NOAEL)	2.47	2.47	2.47	2.47	2.47	2.47	2.47	2.47	3.70	3.70
Selenium (Mouse -TEL)	0.021	0.021	0.021	0.021	0.01	0.021	0.021	0.021	0.032	0.032

Chemical	TRV for NI121	TRV for NI122	TRV <sup>a</sup> for NI122A	TRV for NI123	TRV for NI210	TRV <sup>b</sup> for NI210A	TRV for NI222	TRV for NI322	TRV for NI422	TRV for NI422A
Selenium (Rat -NOAEL)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.038	0.038
Selenium (Sheep -TEL)	0.02	0.02	0.02	0.02	0.013	0.013	0.013	0.013	0.013	0.013
Silver (Mouse -TEL)	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.625	0.625
Sodium (Mouse -LD50)	32.9	32.9	32.9	32.9	32.9	32.9	32.9	32.9	49.4	49.4
Sulfate (Rat -LD90)	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	8.0	8.0
Thallium (Rat -TEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Thallium (Rat -LOAEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06
Vanadium (Cow -NOAEL)	0.47	0.47	0.47	0.47	0.31	0.31	0.31	0.31	0.31	0.31
Vanadium (Mouse -NOAEL)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.68	0.68
Zinc (Rat -NOAEL)	11.83	11.83	11.83	11.83	11.83	11.83	11.83	35.5	11.83	17.75
Zinc (Rat -LOAEL)	4.17	4.17	4.17	4.17	4.17	4.17	4.17	1.17	6.25	6.25

a. The TRVs used for the pygmy rabbit.

b. The TRVs used for the Townsend's big-eared bat, small-footed myotis, and long-eared myotis.

c. TRV for TCDD was used for HPCDD, OCDD, and PCDD.

Table G-3. Summary of toxicity reference values (TRVs in mg/kg-day) for avian functional groups.

Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV <sup>a</sup> for AV143	TRV <sup>b</sup> for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222 A	TRV for AV232
2,3,7,8-Tetrachloro dibenzodioxine (Pheasant -NOAEL)	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6
Aluminum (Chicken - NOAEL)	291.7	291.7	291.7	291.7	291.7	291.7	291.7	291.7	291.7	291.7	291.7
Aluminum (Turkey - NOAEL)	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
Arsenic (Brown-headed cowbird - NOAEL)	0.41	0.41	0.41	0.41	0.41	0.62	0.62	0.62	0.62	0.62	0.62
Arsenic (Mallard - Mortality)	0.64	0.64	0.64	1.29	1.29	0.43	0.43	0.43	0.43	0.43	0.43
Arsenic (Mallard -LD50)	0.24	0.24	0.24	0.48	0.48	0.16	0.16	0.16	0.16	0.16	0.16
Cadmium (Chicken - LOAEL)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Cadmium (Black Duck - LOAEL)	0.018	0.018	0.018	0.35	0.35	0.012	0.012	0.012	0.012	0.012	0.012
Chromium-III (Chicken -NOAEL)	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
Cobalt (Chicken -LOAEL)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Copper (Chicken -NOAEL)	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89
Copper (Chicken -NOAEL)	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92	3.92
Cyanide (European Starling -LD50)	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.06	0.06
Cyanide (Mallard -LD50)	0.009	0.009	0.009	0.018	0.018	0.006	0.006	0.006	0.006	0.006	0.006



Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV <sup>a</sup> for AV143	TRV <sup>b</sup> for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222 A	TRV for AV232
Fluoride (Screech Owl -NOAEL)	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Lead (Chicken -NOAEL)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Lead (European Starling - LOAEL)	0.03	0.03	0.03	0.03	0.03	0.04	0.08	0.04	0.04	0.04	0.04
Manganese (Chicken -NOAEL)	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1	70.1
Mercury (Inorganic) (Japanese quail -NOAEL)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Mercury (Inorganic) (Chicken -NOAEL)	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833	0.833
Mosquito (Inorganic) (American black duck -AFL)	0.0047	0.0047	0.0047	0.0094	0.0094	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Mercury (Mallard -Reproduction)	0.004	0.004	0.004	0.008	0.008	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Mercury (Pheasant -AFL)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Mercury (Pheasant - LOAEL-r)	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Nickel (Chicken -NOAEL)	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06	2.06
Nickel (Mallard -NOAEL)	8.75	8.75	8.75	17.50	17.50	5.83	5.83	5.83	5.83	5.83	5.83
Selenium (Black Crowned Night Heron -LOAEL)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Selenium (Chicken -NOAEL)	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165

Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV <sup>a</sup> for AV143	TRV <sup>b</sup> for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222 A	TRV for AV232
Selenium (Mallard - NOAEL)	0.13	0.13	0.13	0.25	0.25	0.083	0.083	0.083	0.083	0.083	0.083
Sulfate (Turkey - NOAEL)	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Thallium (Quail - FEL)	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
Vanadium (Chicken - NOAEL)	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142
Vanadium (Mallard - NOAEL)	0.13	0.13	0.13	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08
Zinc (Chicken - LOAEL)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Zinc (Mallard - LOAEL)	12.94	12.94	12.94	25.88	25.88	8.63	8.63	8.63	8.63	8.63	8.63

Table G-3.

Chemical	TRV'd for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV'd for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
2,3,7,8-tetrachloro dibenzodioxin (Pecan - NOAEL)	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	2.3E-6	3.5E-6	3.5E-6	3.5E-6	3.5E-6
Aluminum (Chicken - NOAEL)	291.7	291.7	291.7	291.7	291.7	291.7	291.7	437.5	437.5	437.5	437.5
Aluminum (Turkey - NOAEL)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	13.0	13.0	13.0	13.0
Arsenic (Brown-headed cowbird - NOAEL)	0.62	0.62	0.62	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Arsenic (Mallard - Mortality)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Arsenic (Mallard - LD50)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Cadmium (Black Duck - LOAEL)	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Cadmium (Chicken - LOAEL)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.27	0.27	0.27	0.27
Chromium-III (Chicken - NOAEL)	1.36	1.36	1.36	1.36	1.36	1.36	1.36	2.04	2.04	2.04	2.04
Cobalt (Chicken - LOAEL)	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.32	0.32	0.32	0.32
Copper (Chicken - NOAEL)	3.92	3.92	3.92	3.92	3.92	3.92	3.92	5.88	5.88	5.88	5.88
Copper (Chicken - NOAEL)	27.89	27.89	27.89	27.89	27.89	27.89	27.89	41.92	41.92	41.92	41.92
Cyanide (European Starling - LD50)	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Cyanide (Mallard - LD50)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006

Chemical	TRVd for AV233	TRV for AV241	TRV for AV242	TRVe for AV310	TRVd for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
Fluoride (Screech Owl - NOAEL)	1.3	1.3	1.3	1.95	1.95	1.95	1.95	1.3	1.3	1.3	1.3
Lead (Chicken - NOAEL)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.72	0.72	0.72	0.72
Lead (European Starling - LOAEL)	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Lead (American Kestrel - Reproduction)	0.321	0.321	0.321	0.963	0.481	0.481	0.481	0.321	0.321	0.321	0.321
Manganese (Chicken - NOAEL)	70.1	70.1	70.1	70.1	70.1	70.1	70.1	105.2	105.2	105.2	105.2
Mercury (Inorganic) (Japanese quail - NOAEL)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.24	0.24	0.24	0.24
Mercury (Inorganic) (Chicken - NOAEL)	0.833	0.833	0.833	0.833	0.833	0.833	0.833	1.263	1.263	1.263	1.263
Mercury (Inorganic) (American black duck - AEL)	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Mercury (Inorganic) (Grey pheasant - AEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
Mercury (Pheasant - LOAEL - r)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005	0.005	0.005	0.005
Mercury (Mallard - Reproduction)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Mercury (Pheasant - AEL)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.0059	0.0059	0.0059	0.0059
Mercury (Mallard - Reproduction)	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027
Nickel (Chicken - NOAEL)	2.06	2.06	2.06	2.06	2.06	2.06	2.06	3.08	3.08	3.08	3.08

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
Nickel (Mallard -NOAEL)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Selenium (Black Crowned Night Heron -LOAEL)	0.052	0.052	0.052	0.078	0.078	0.078	0.078	0.052	0.052	0.052	0.052
Selenium (Chicken - NOAEL)	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0165	0.0248	0.0248	0.0248	0.0248
Selenium (Mallard - NOAEL)	0.090	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Sulfates	8.6	8.6	8.6	8.6	8.6	8.6	8.6	13.0	13.0	13.0	13.0
Thallium (Quail -TEL)	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.074	0.074	0.074	0.074
Vanadium (Chicken - NOAEL)	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.213	0.213	0.213	0.213
Vanadium (Mallard - NOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Zinc (Chicken -LOAEL)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0
Zinc (Mallard -LOAEL)	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63

a. The TRVs used for the trumpeter swan.

b. The TRVs used for the black tern.

c. TRV for TCDD was used for lipCDD, OCDD, and PeCDD.

d. The TRVs used for the white-faced ibis.

e. The TRVs used for the northern goshawk and peregrine falcon.

f. The TRVs used for the bald eagle, ferruginous hawk, and loggerhead shrike.

**COPC:****2,3,7,8-Tetrachloro Dibenzodioxin (TCDD), CAS 1746-01-6****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral

**Test Endpoint:**

NOAEL

**Reference:**Murray, F.J. et al. 1979, "Three-generation reproduction study of rats given 2,3,7,8-tetrachloro dibenzo-p-dioxin (TCDD) in the diet," *Toxicol. Appl. Pharmacol.*, 50:241-252.**QCE:**

0.000001 mg/kg-day

				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of male and female rats, and juveniles were also tested (three generations)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Long-term (3 generations, > 1 year) including critical lifestages (reproduction).
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Old endpoints, no receptor or endocrine specific measures.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10 <sup>-6</sup>	10 <sup>-6</sup>	10 <sup>-6</sup>	QCE = quantified critical endpoint
TRV	1E-06	5E-07	3.3E-07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1E-06	Test organism is in the same order and trophic level as the functional group members	none
2	5E-07	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.3E-07	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:****2,3,7,8-Tetrachloro Dibenzodioxin (TCDD)** CAS 1746-01-6**Test Organisms:**

Ring-necked pheasants (Omnivore, Order-Galliformes)

**Exposure Medium:**

Intraperitoneal injection

**Test Endpoint:**

NOAEL

**Reference:**Nosek, J.A., S.R. Craven, J.R. Sullivan, S.S. Hurley, and R.E. Peterson, 1992, "Toxicity and reproductive effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin in ring-necked pheasant hens," *J. Toxicol. Environ. Health.*, 35:187-198.**QCE:**

.000014 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	7 females per dose tested
Q <sub>1</sub>	1	1	1	Intraperitoneal injection unlikely in field
Q <sub>2</sub>	1	1	1	10 weeks and during a critical lifestage (reproduction)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Reasonable study design, looked at reproduction.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.4E-5	1.4E-5	1.4E-5	QCE = quantified critical endpoint
TRV	7.0E-6	3.5E-6	2.3E-6	Toxicity Reference Value = QCE/Total AF

Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.0E-6	Test organism is in the same order and trophic level as the functional group members	none
2	3.5E-6	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.3E-6	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Aluminum CAS 1784-27-2****Test Organisms:**

Cow (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**

Valdivia, R., C.B. Ammerman, C.J. Wilcox, and P.R. Henry, 1978. Effect of dietary aluminum on animal performance and tissue mineral levels in growing steers. *Journal of Animal Science*, 47:1351, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC

**QCE:**

15.3 mg/kg-day      1200mg/kg food\* 6.33kg  
food/day(cited)/262kgBW (52.94% Aluminum)      (cited)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only males tested.
Q <sub>1</sub>	1	1	1	Eco logically relevant endpoints
Q <sub>2</sub>	2	2	2	Subchronic study (84 days)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages not examined. NOAEL established. Test organisms exposed to AlCl <sub>3</sub> ·6H <sub>2</sub> O (calculated as Aluminum only)
M	0.5	0.5	0.5	Dry feed spiked with Aluminum chloride, very soluble, not consistent with soil forms.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	15.3	15.3	15.3	QCE = quantified critical endpoint
TRV	2.55	1.28	0.85	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.55	Test organism is in the same order and trophic level as the functional group members	none
2	1.28	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.85	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A



**COPC:****Aluminum CAS 7784-27-2**

**Test Organisms:** Rabbit (Herbivore, Order-Lagomorpha)  
**Exposure Medium:** Oral in diet  
**Test Endpoint:** NOAEL  
**Reference:** Nekipelov, M.K, 1966 Hygienic standard for aluminum nitrate in water basins. Hyg. Sanit. (USSR), 3 :204, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC  
**QCE:** 0.145 mg/kg-day (as aluminum)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study (6 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. NOAEL established. Test organisms fed Al(NO <sub>3</sub> ) <sub>3</sub> (calculated as aluminum only).
M	1	1	1	Appropriate exposure medium for INEL
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.145	0.145	0.145	QCE = quantified critical endpoint
TRV	0.0161	0.0081	0.0054	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0161	Test organism is in the same order and trophic level as the functional group members	none
2	0.0081	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.0054	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:****Aluminum CAS 7784-27-2****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

TDLo - Developmental abnormalities, including death, in offspring

**Reference:**Paternain, J.L., J.L. Domingo, J.M., Llober, J. Corbella, 1988, "Embryotoxic and Teratogenic Effects of Aluminum Nitrate in Rats Upon Oral Administration", *Teratology*, 38:253-257**QCE:**

26.1 mg/kg-day (as aluminum)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only ten pregnant rats for each dose, and no males, were tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study (dose given days 6 to 14 of pregnancy)
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Limited information but reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
M	0.5	0.5	0.5	Soluble Aluminum nitrate given by gavage (calculated as aluminum only)
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26.1	26.1	26.1	QCE = quantified critical endpoint
TRV	6.53	3.26	2.18	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.53	Test organism is in the same order and trophic level as the functional group members	none
2	3.26	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.18	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Aluminum CAS 7784-27-2  
**Test Organisms:** Rat (Omnivore, Order-Rodentia)  
**Exposure Medium:** Oral in diet  
**Test Endpoint:** Adverse effect level - significantly retarded growth in young  
**Reference:** Thurston, H., G.R. Gilmore, and J.E. Swales, 1972. Aluminum retention and toxicity in chronic renal failure, The Lancet, 1: 881-883  
**QCE:** 57.1 mg/kg-day (as aluminum) (8 mg/rat-day)/0.036kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	3 to 4-week old animals tested, sex not specified.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration (4 weeks)
Q <sub>3</sub>	2	2	2	LOAEL-reduced growth rate, increased bone Al concentrations
U	2	2	2	Sensitive life stage examined. No NOAEL established. Test animals exposed to aluminum hydroxide (calculated as aluminum only).
M	0.5	0.5	0.5	Feed was spiked with highly soluble form of metal salt, not consistent with soil forms. Experimental bioavailability expected to be substantially enhanced compared to environmental exposures.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	57.1	57.1	57.1	QCE = quantified critical endpoint
TRV	7.14	3.57	2.38	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.14	Test organism is in the same order and trophic level as the functional group members	none
2	3.57	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.38	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

\*BW and ingestion rate specified in the article

**COPC:****Aluminum** CAS 13473-90-0**Test Organisms:**

Turkeys (Omnivore, Order-Galliformes)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**

Cakir, A., T.W. Sullivan, and F.B. Mather, 1978. Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum. Poultry Science 57:498, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC

**QCE:**

182.3 mg/kg-day [as Aluminum]

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (28 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al <sub>2</sub> (SO <sub>4</sub> )·18H <sub>2</sub> O (calculated as aluminum).
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	182.3	182.3	182.3	QCE = quantified critical endpoint
TRV	22.79	11.39	7.60	Toxicity Reference Value = QCE/Total AF
<b>Appropriate Functional Groups:</b>				
R Value	TRV (mg/kg-day)	Justification		Appropriate Functional Group
1	22.79	Test organism is in the same order and trophic level as the functional group members		none
2	11.39	Test organism is in a different order and same trophic level from the functional group members		AV422, AV432, AV433, AV442
3	7.60	Test organism is in a different order and trophic level from the functional group members		AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Aluminum CAS 7784-27-2****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**

Miller, D. and R.R. Kifer, 1970. Effect of glutamic acid and antacids on chick bioassay of protein quality of fish meals. Poultry Science 49:1327, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC

**QCE:**

900 mg/kg-day [as aluminum]

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	180 1-day old chicks tested
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (19 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al(OH) <sub>3</sub> (calculated as aluminum only).
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	900	900	900	QCE = quantified critical endpoint
TRV	225	112.5	75	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	225	Test organism is in the same order and trophic level as the functional group members	none
2	112.5	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	75	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:**

Antimony (Antimony Potassium Tartrate) CAS# 7440-36-0

**Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:**

Water

**Test Endpoint:**

LOAEL-s

Apparent slight decrease in lifespan of female CD-1 mice (significance unknown)

**Reference:**Schroeder, H.A., M. Mitchner, and J.J. Balassa, 1968, *Zirconium, Niobium, Antimony and Fluorine in Mice: Effects of Growth Survival and Tissue Levels*, Journal of Nutrition, 95:95-101.

Kanisawa, M. and H.A. Schroeder, 1969, "Life term studies on the effect of trace elements on spontaneous tumor in mice and rats." Cancer Research, 29(4):892-895

**QCE:**

0.35 mg/kg-day

5mg/L\*7.0mL/100g-day\*L/1000mL\*1000g/1kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals.
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint could occur in ROC, but of uncertain ecological significance
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined.
M	0.5	0.5	0.5	Soluble salts in the drinking water were used
Total AF	0.5	1.0	1.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.35	0.35	0.35	QCE = quantified critical endpoint
TRV	0.70	0.35	0.23	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.70	Test organism is in the same order and trophic level as the functional group members	none
2	0.35	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.23	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:****Arsenic CAS 7440-38-2****Test Organisms:**

Domestic Sheep

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**Eisler, R., 1988, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A synoptic Review*, US Fish and Wildlife Service Biological Report, 85(1.12)**QCE:**

2.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Secondary source, only one dose level.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	0.19	0.097	0.064	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.19	Test organism is in the same order and trophic level as the functional group members	none
2	0.097	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.064	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:**

Arsenic CAS # 7440-38-2

**Test Organisms:**

Brown-headed cowbird (Insectivore, Order-Passeriformes)

**Exposure Medium:**

NA

**Test Endpoint:**

NOAEL

**Reference:**

US Fish and Wildlife Service, 1969, Bureau of Sport Fisheries and Wildlife, Publication 74, pp 56-57

**QCE:**

2.46 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males only.
Q <sub>1</sub>	1	1	1	Mortality
Q <sub>2</sub>	1	1	1	Chronic (7 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Four dose levels- both a loael and noael established
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.46	2.46	2.46	QCE = quantified critical endpoint
TRV	1.23	0.62	0.41	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.62	Test organism is in a different order and same trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.41	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442



**COPC:** Arsenic CAS# 7440-38-2 Don't use  
**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)  
**Exposure Medium:** NA  
**Test Endpoint:** LD<sub>50</sub>  
**Reference:** National Academy of Sciences (NAS), 1977, *Arsenic*, Washington DC  
**QCE:** 39 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with little supporting variation data.
Q <sub>1</sub>	1	1	1	Relevant effect.
Q <sub>2</sub>	3	3	3	Study duration was acute
Q <sub>3</sub>	3	3	3	QCEL is and LD <sub>50</sub>
U	3	3	3	Old study, secondary source
M	1	1	1	Appropriate exposure medium for INEL
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	39	39	39	QCE = quantified critical endpoint
TRV	0.48	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.48	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:**

Arsenic CAS 7740-38-2 don't use can't find

**Test Organisms:**

Domestic sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**Eisler, R. 1988, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, US Fish and Wildlife Service Biological Report, 85(1.12):92pp**QCE:**

2.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q <sub>1</sub>	1	1	1	Relevant effect.
Q <sub>2</sub>	2	2	2	Subacute duration.
Q <sub>3</sub>	1	1	1	NOEL endpoint.
U	3	3	3	Secondary source, only one dose level.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	.130	.064	.043	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.130	Test organism is in the same order and trophic level as the functional group members	none
2	.064	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	.043	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Arsenic CAS7778-43-0  
**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)  
**Exposure Medium:** Oral in diet (As as sodium arsenite)  
**Test Endpoint:** mortality  
**Reference:** U.S. Fish and Wildlife Service. 1964. Pesticide-wildlife studies, 1963: a review of Fish and Wildlife Service investigations during the calendar year. FWS Circular 199.  
**QCE:** 5.14 mg/kg-day ((51.35mg As/kg food)\*(0.1 kg food/day))/(1kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Same trophic level but different order than members of functional groups
I	2	2	2	
Q <sub>1</sub>	1	1	1	Mortality, is ecologically relevant
Q <sub>2</sub>	1	1	1	Chronic duration (over 128 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Multiple doses (100, 250, 500, and 1000 ppm sodium arsenite) examined with both a NOAEL and a LOAEL established. However, no reproductive endpoints examined.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.14	5.14	5.14	QCE = quantified critical endpoint
TRV	1.29	0.64	0.43	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.29	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.64	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.43	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:****Arsenic CAS 7778-43-0****Test Organisms:**

Dog (Omnivore, Order-Carnivora)

**Exposure Medium:**

Diet as sodium arsenite or sodium arsenate

**Test Endpoint:**

NOAEL

**Reference:**Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.**QCE:**

1.28 mg/kg-day (50 mg/kg food)\*(0.24 kg food /day)/(9.41 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Reasonable number of males and females studied (24)
Q <sub>1</sub>	1	1	1	Weight loss, survival, endpoint ecologically significant
Q <sub>2</sub>	1	1	1	Chronic study (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Reasonable study, but no reproductive endpoints examined in the two years.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.28	1.28	1.28	QCE = quantified critical endpoint
TRV	0.32	0.16	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.32	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate specified

**COPC:****Arsenic CAS 7778-43-0****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet as sodium arsenate or sodium arsenite

**Test Endpoint:**

NOAEL

**Reference:**Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:133-147**QCE:**

3.1mg/kg-day (62.5 mg/kg food)\*(0.0189kg/day)/(0.382 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	300 weanling Data do not show a good dose-response curve low-dose range.
Q <sub>1</sub>	1	1	1	Levels of 62.5 ppm As as arsenite and 125 ppm As as arsenate did not cause common bile duct enlargement and did not affect survival. Weight was slightly reduced in females at the 62.5 ppm As as arsenite.
Q <sub>2</sub>	1	1	1	Chronic study.
Q <sub>3</sub>	1	1	1	NOAEL using lowest NOAEL from either arsenite or arsenate
U	2	2	2	Good overall design, but no reproductive studies in the two years.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.1	3.1	3.1	QCE = quantified critical endpoint
TRV	0.78	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.78	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.27	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:****Arsenic CAS 7778-43-0 Need to get this study****Test Organisms:**

Mice (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet as sodium arsenate or sodium arsenite

**Test Endpoint:**

LOAEL

**Reference:**Schroeder, H.A., and M. Mitchner, 1971. *Toxic effects of trace elements on the reproduction of mice and rats*. Arch. Environ. Health. 23:102-106.**QCE:**

1.25 mg/kg-day

 $((5 \text{ mg As/L H}_2\text{O}) * (0.0075 \text{ L/day})) / (0.003 \text{ kg BW})$ 

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	3 generations, however only one dosage
Q <sub>1</sub>	1	1	1	Declining litter sized with each successive generation
Q <sub>2</sub>	1	1	1	Chronic study.
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Only one dose level, no NOAEL established.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	0.16	0.08	0.052	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.16	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.052	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:****Barium CAS 7440-39-3****Test Organisms:**

Dog (Omnivore, Order-Carnivora)

**Exposure Medium:**

Oral

**Test Endpoint:**

FEL-1 LD-100

**Reference:**

Venugopal, B., and T.D. Luckey, 1978, The Toxicity of Metals in Mammals, Plenum Press, New York.

**QCE:**

59 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information (secondary source)
Q <sub>1</sub>	1	1	1	Endpoint expected to be ecologically significant
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	Lethal endpoint
U	3	3	3	Acute study; no other information (secondary source)
M	1	1	1	Appropriate exposure medium for INEL
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	0.73	0.36	0.24	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.73	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.36	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.24	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Barium CAS 7440-39-3  
**Test Organisms:** Rat (Omnivore, Order-Rodentia)  
**Exposure Medium:** Water  
**Test Endpoint:** NOAEL  
**Reference:** Perry, H.M. et al. 1989, "Hypertension and associated cardiovascular abnormalities induced by chronic barium feeding," Journal of Toxicology and Environmental Health, 28(3):373-388.  
Kopp, S.J. et al. 1985, "Cardiovascular dysfunction and hypersensitivity to sodium pentobarbital induced by chronic barium chloride ingestion, Toxicology and Applied Pharmacology, 77(23):303-314.

**QCE:** .051mg/kg-day (1 mg/L)\*(0.022L/day)/0.435kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Although endpoint examined (increased blood pressure at higher doses) could occur in ecological receptors, the absence of any effects on growth and longevity at any dose argues against its ecological relevance. But at the NOAEL dose, no hypersensitivity was observed.
Q <sub>2</sub>	1	1	1	Chronic study (16 months)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Concordant results in several detailed studies
M	0.5	0.5	0.5	Soluble salt in the drinking water was used
Total AF	0.50	1.00	1.50	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	.051	.051	.051	QCE = quantified critical endpoint
TRV	0.10	0.05	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.10	Test organism is in the same order and trophic level as the functional group members	none
2	0.05	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.03	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*BW given by an earlier Perry article, ingestion rate specified in the article

\*\*note-10ppm had some adverse effects such as an increase in blood pressure and tissue concentration.



**COPC:****Beryllium (Beryllium sulfate) CAS 7440-41-7****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Water

**Test Endpoint:**

NOAEL

**Reference:**Schroeder, H.A., and M. Mitchner, 1975, *Life-Term Studies in Rats: Effects of Aluminum, Barium, Beryllium and Tungsten*, J. Nutr. 105: 421-427.**QCE:**

0.66mg/kg-day (5mg/L water)\*(0.046L/day)/0.35 kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined
M	0.5	0.5	0.5	Soluble salt in the drinking water used
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.66	0.66	0.66	QCE = quantified critical endpoint
TRV	0.66	0.33	0.22	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.66	Test organism is in the same order and trophic level as the functional group members	none
2	.33	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	.22	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*Ingestion rate specified by EPA (EPA, 1985a).

**COPC:****Cadmium CAS 7440-43-9****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

LOAEL

Body weight gain, mortality

**Reference:**Pritzel, M.C., Y.H. Lie, E.W. Kienholz, and C.E. Whiteman, 1974, *The Effect of Dietary Cadmium on the Development of Young Chickens*, Poultry Sci. 53:2026-2029.**QCE:**

29 mg/kg-day

(400mg/kg)\*(0.11kg/day)/0.151 kg bw

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males tested, 100
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	3	3	3	LOAEL endpoint, but mortality observed
U	3	3	3	No reproductive endpoints examined, however, sensitive life stage examined. High doses tested. Presence of zinc in diet may have influenced (decreased) cadmium toxicity. NOAEL not identified.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	29	29	29	QCE = quantified critical endpoint
TRV	0.81	0.40	0.27	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.81	Test organism is in the same order and trophic level as the functional group members	none
2	0.40	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.27	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Ingestion rate specified

\*\*BW estimated through the Rosomer article, 1961.

**COPC:****Cadmium CAS 22357-48-0****Test Organisms:**

Black Duck (Herbivore, Order-Anseriformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

LOAEL

**Reference:**Heinz, G.H. and Haseltine, S.D., 1983, "Altered Avoidance Behavior of Young Black Ducks Fed Cadmium". *Environ. Toxicol. Chem.* 2:419-421. As cited in Eisler, 1985**QCE:**

0.14 mg/kg-day

(4 mg/kg)\*(0.06 kg/day)/1.7 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested, males, females and juveniles given the doses.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic (90-day) exposure
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Reproductive endpoints and sensitive life stage examined, but only data given was on the flight response of the juveniles.
M	0.5	0.5	0.5	Cadmium chloride in the feed
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.035	0.018	0.012	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.035	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.018	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.012	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:****Cadmium CAS 7440-43-9****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

LOAEL

**Reference:**Wills, J.H., Groblewski, G.E., Coulston, F., 1981, *Chronic and Multigeneration Toxicities of Small Concentrations of Cadmium in the Diet of Rats*, Ecotoxicol. Environ. Safety, 5:452-464.ATSDR, Agency for Toxic Substance Disease Registry, 1989, *Toxicological Profile for Cadmium*, March, 1989.**QCE:**

5.5 E-3 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males females and juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	NOAEL
U	1	1	1	Excellent design, four-generational study.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.5E-3	5.5E-3	5.5E-3	QCE = quantified critical endpoint
TRV	.003	.001	8E-4	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.003	Test organism is in the same order and trophic level as the functional group members	none
2	0.001	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8E-4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Chromium(III) CAS 7440-47-3****Test Organisms:** Rat (Omnivore, Order-Rodentia)**Exposure Medium:** Diet**Test Endpoint:** NOAEL

Treatments had no effect on life expectancy, food consumption, growth rate, or cancer incidence

**Reference:** Ivankovic and Preussmann, 1975, *Absence of Toxic and Carcinogenic Effects After Administration of High Doses of Chromic Oxide Pigment in Subacute and Long-Term Feeding Experiments in Rats*, Food Cosmet. Toxicol. 13(3): 347-351.**QCE:** 1500 mg/kg-day

1800 g/kg total dose consumed at highest dose rate, administered 5 days/week for 120 weeks (~840 days total), corrected for % Cr.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1500	1500	1500	QCE = quantified critical endpoint
TRV	750	375	250	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	750	Test organism is in the same order and trophic level as the functional group members	none
2	375	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	250	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Chloride**

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)  
**Exposure Medium:** Oral in diet  
**Test Endpoint:** LD<sub>50</sub>  
**Reference:** Iyakuhin Kenkyu, 21:57, RTECS.  
**QCE:** 714 mg/kg-day (from potassium chloride)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - lethality level
U	3	3	3	Limited information, no reproductive endpoints and sensitive life stage (offspring) examines. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	714	714	714	QCE = quantified critical endpoint
TRV	8.81	4.41	2.94	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.81	Test organism is in the same order and trophic level as the functional group members	none
2	4.41	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.94	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Chromium (III) CAS 7440-47-3****Test Organisms:**

Chicken (Omnivore, Order: Galliformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**Romoser, G.L., W.A. Dudley, L.J. Machlin, and L. Loveless, 1961, *Toxicity of Vanadium and Chromium for the Growing Chick*, Poultry Science, 40:1171-1173.**QCE:**

49 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Primary source available
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	2	2	2	Subchronic exposure duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Old study, limited endpoints
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	49	49	49	QCE = quantified critical endpoint
TRV	4.08	2.04	1.36	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.08	Test organism is in the same order and trophic level as the functional group members	none
2	2.04	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	1.36	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Chromium (VI) CAS 7440-47-3****Test Organisms:**

Dog (Omnivore, Order-Carnivora)

**Exposure Medium:**

Water

**Test Endpoint:**

NOAEL

**Reference:**

Steven et al. (1976) cited in Eisler (1986)

Anwar, R.A., et al., 1961, "Chronic Toxicity Studies. Part III. Chronic Toxicity of Cadmium and Chromium in Dogs", *Archives of Environmental Health*, 3:456-460Steven, J.D. et al., 1976, *Effects of Chromium in the Canadian Environment*, RCC No. 15017, National Resources Council, Ottawa, Canada.**QCE:**

0.30 mg/kg-day

11.2 mg/L\*(3.1mL\*\*/100g-day)\*8730g\*1L/1000mL/8.73 Kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of female dogs only. No males tested.
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic duration (4 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint studied, but good duration of testing.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.30	0.30	0.30	QCE = quantified critical endpoint
TRV	0.15	0.08	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.05	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*\* Water consumption information is from the Dames and Moore animal data chart.



**COPC:****Chromium(VI)CAS 7440-47-3****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:**

Water

**Test Endpoint:**

FEL-r

**Reference:**

Trivedi, B., et al., 1989, 'Embroyotoxicity and fetotoxicity of orally administered hexavalent chromium in mice,' Reproductive Toxicology, 3(4);275-278.

**QCE:**59 mg/kg-day  
.030 kg

Specified from 1.76 mg/mouse-day and a BW of

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, variability assessed appropriately and not high.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic exposure duration
Q <sub>3</sub>	3	3	3	FEL endpoint - fetal development harmed
U	2	2	2	Well designed study, appropriate endpoints well characterized, but no NOAEL identified.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	9.83	4.92	3.28	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.83	Test organism is in the same order and trophic level as the functional group members	none
2	4.92	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.28	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Cobalt (cobalt chloride) CAS 7440-48-4

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL Increased mortality associated with *S. gallinarum* infection

**Reference:** Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," Journal of Nutrition, 109:501-507.

**QCE:** 10.2 mg/kg-day 100 ppm in diet converted to dose using an ingestion rate\* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL endpoint or FEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
M	1	1	1	Appropriate exposure medium for INEL
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.64	0.32	0.21	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.64	Test organism is in the same order and trophic level as the functional group members	none
2	0.32	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.21	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Estimated as  $0.0582 \text{ Wt}^{0.651}$  (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

**COPC:****Cobalt CAS 7440-48-4****Test Organisms:**

Dog (Omnivore, Order-Carnivora)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiol. 128:345-348.Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.**QCE:**

5 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q <sub>1</sub>	0.1	0.1	0.1	Endpoint of unknown ecological significance
Q <sub>2</sub>	2	2	2	Subchronic duration (4 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	4.17	2.08	1.39	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.17	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.08	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.39	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Cobalt CAS 7440-48-4  
**Test Organisms:** Rat (Omnivore, Order-Rodentia)  
**Exposure Medium:** Diet  
**Test Endpoint:** NOAEL  
**Reference:** Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," Neurobehav. Toxicol. and Teratology, 5:9-15.  
Agency for Toxic Substance Disease Registry (ATSDR), 1990, Draft: Toxicological Profile for Cobalt, October.

**QCE:** 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q <sub>1</sub>	1	1	1	Endpoint of relevant ecological significance
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Copper CAS# 7440-50-8  
**Test Organisms:** Chicken (Omnivore, Order-Galliformes)  
**Exposure Medium:** Oral in diet (copper oxide)  
**Test Endpoint:** NOAEL  
**Reference:** Mehring, A.L., Jr., et al., 1960, "The Tolerance of Growing Chicken for Dietary Copper". *Poultry Sci.* 39:713-719  
**QCE:** 47 mg/kg-day 570 ppm in diet converted by multiplying by 0.044 kg food/day ingestion rate, and dividing by 0.534kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Eleven dose levels during critical growth period, growth, mortality- for 10 weeks.
Q <sub>1</sub>	2	2	2	
Q <sub>2</sub>	1	1	1	Chronic exposure duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	47	47	47	QCE = quantified critical endpoint
TRV	11.75	5.88	3.92	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	11.75	Test organism is in the same order and trophic level as the functional group members	none
2	05.88	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	3.92	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Copper CAS 7440-50-8****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**Stevenson, M.H., and N. Jackson, 1981, "An Attempt to Distinguish Between the Direct and Indirect Effects, in the Laying Domestic Fowl, of Added Dietary Sulphate", *British Journal of Nutrition*, 46(1):71-76.**QCE:**

1006 mg/kg-day [1408 mg Cu/day/1.4 kg BW]\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Rather small group sizes (n=6)
Q <sub>1</sub>	1	1	1	Endpoints are body weight, food intake, egg production, hepatic metals concentrations. Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Subchronic exposure and small group sizes, but detailed characterization of relevant endpoints.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1006	1006	1006	QCE = quantified critical endpoint
TRV	83.83	41.92	27.89	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	83.83	Test organism is in the same order and trophic level as the functional group members	none
2	41.92	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	27.89	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Ingestion rate and body weight specified in article

**COPC:** Copper CAS 7440-50-3  
(copper sulfate)

**Test Organisms:** Mink (Carnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Aulerich, R.J., et al., 1982, *Effects of Supplemental Dietary Copper on Growth, Reproductive Performance and Kit Survival of Standard Dark Mink and the Acute Toxicity of Copper to Mink*, Journal of Animal Science, 55(2):337-43.

**QCE:** 11.71 mg/kg-day      25mg/kg\*0.175kg fed/day/1 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Group sizes were small relative to observed variation in responses
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic exposure
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Parameters observed were relevant but not exhaustive
M	1	1	1	Appropriate exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	11.71	11.71	11.71	QCE = quantified critical endpoint
TRV	1.95	0.98	0.65	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.95	Test organism is in the same order and trophic level as the functional group members	M322
2	.98	Test organism is in a different order and same trophic level from the functional group members	none
3	0.65	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:****Copper CAS 7440-50-8****Test Organisms:**

Rat (F334/N) (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**

Hebert, C.D., et al., 1993, *Subchronic Toxicity of Cupric Sulfate Administered in Drinking Water and Feed to Rats and Mice*, Fundamentals and Applied Toxicology, 21:461-475.

**QCE:**

66 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Males appeared to be more sensitive than females
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic exposure
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Thorough and well-designed study, but subchronic duration prevented evaluation of long-term effects, e.g., development of tolerance as reported by others.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	66	66	66	QCE = quantified critical endpoint
TRV	5.50	2.75	1.83	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.50	Test organism is in the same order and trophic level as the functional group members	none
2	2.75	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322



**COPC:****Cyanide CAS 57-12-5****Test Organisms:**

European Starling (Insectivore, Order-Passeriformes)

**Exposure Medium:**

No vehicle indicated

**Test Endpoint:**

LD50 Survival

**Reference:**Wiemeyer, S.N., et al., 1986, *Acute Oral Toxicity of Sodium Cyanide in Birds*, J. Wildl. Dis. 22:538-546.**QCE:**

9 mg/kg 17mg NaCN/kgBW\*(26.02mg CN/49.01mg NaCN)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and females tested
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	Lethality endpoint
U	3	3	3	Limited endpoint
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9	9	9	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.06	Test organism is in a different order and same trophic level from the functional group members	AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.04	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:**

Cyanide CAS 57-2-5

**Test Organisms:**

Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:**

No vehicle indicated

**Test Endpoint:**

LD50 Survival

**Reference:**

E.F. Hill, Patuxent Wildlife Research Center, personal communication. As cited in Eisler, R., 1991, *Cyanide Hazards to Fish, Wildlife, and Invertebrates; A Synoptic Review*, U.S. Fish Wildlife Service Biological Report, 85(1.23):55p.

**QCE:**

1.43 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	Lethality endpoint
U	3	3	3	Limited information
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.43	1.43	1.43	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.018	Test organism is in the same order and trophic level	AV142, AV143
2	.009	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	.006	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

COPC:

Cyanide CAS 57-12-5

Test Organisms:

Pig (Sows) (Omnivore, Order-Artiodactyla)

Exposure Medium:

Diet

Test Endpoint:

LOAEL

Reference:

Tewe, O.O., and J.H. Maner, 1981, *Performance and Pathophysiological Changes in Pregnant Pigs Fed Cassava Diets Containing Different Levels of Cyanide*, Res. Veter. Sci. 30: 147-15 .

QCE:

9.45 mg/kg-day (520.7mg/kg cassava)\*(3.1kg/day)/170.8kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Limited number of animals
Q <sub>1</sub>	0.5	0.5	0.5	Ecologically relevance questionable
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Limited information, but sensitive life stage tested.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9.45	9.45	9.45	QCE = quantified critical endpoint
TRV	0.79	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.79	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.26	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M322

**COPC:**

Cyanide CAS 57-12-5

**Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Growth

**Reference:**

Howard, J.W., and R.F. Hanzal, 1955, *Chronic Toxicity for Rats of Food Treated with Hydrogen Cyanide*. J. Agric. Food Chem. 3:325-329.

US EPA, 1984, *Health Effect Assessment for Cyanides*, Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, DC.

**QCE:**

10.8 mg/kg-day

As specified in IRIS

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate animals
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Two doses but no LOAEL identified, older study, but consistent with reproduction study results.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.8	10.8	10.8	QCE = quantified critical endpoint
TRV	5.40	2.70	1.80	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.40	Test organism is in the same order and trophic level as the functional group members	none
2	2.70	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.80	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Fluoride CAS # 16984-48-8****Test Organisms:**

Mink (Carnivore, Order-Carnivora)

**Exposure Medium:**

Oral in diet (NaF)

**Test Endpoint:**

NOAEL

**Reference:**Aulerich, R.J., et al., 1987. "Chronic toxicity of Dietary Fluorine in Mink", *J. Animal. Sci.* 65:1759-1767**QCE:**

31.37 mg/kg-day

 $(229\text{mg/kg-day}) \cdot (0.137\text{kg/day}) / 1\text{kg BW}$ 

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females (60 each) tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (382-days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design, looked at sensitive life stages and reproduction
Total AF	1	2	3	$R \cdot I \cdot Q_1 \cdot Q_2 \cdot Q_3 \cdot U = \text{Total AF}$
QCE (mg/kg-day)	31.37	31.37	31.37	QCE = quantified critical endpoint
TRV	31.37	15.69	10.46	Toxicity Reference Value = QCE/Total AF

	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	31.37	Test organism is in the same order and trophic level as the functional group members	M322
2	15.69	Test organism is in a different order and same trophic level from the functional group members	none
3	10.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:**

Fluoride CAS # 14984-48-8

**Test Organisms:**

Screech Owl (Carnivore, Order-Strigiformes)

**Exposure Medium:**

Oral in diet (NaF)

**Test Endpoint:**

NOAEL

**Reference:**

Patte, O.H., S.N. Wiemeyer, D.M. Swienford, 1988, "Effects of Dietary Fluoride on Reproduction in Eastern Screech Owls", *Arch. Environ. Contam. Toxicol.* 17:213-218

**QCE:**

7.8 mg/kg-day

(56.5 mg/kg food)\*(0.025kg/day)/0.181kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of animals (33 males and 33 females)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (5-6 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Good design, the study exposure included critical life stage, but only two dose levels.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.8	7.8	7.8	QCE = quantified critical endpoint
TRV	3.90	1.95	1.30	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.90	Test organism is in the same order and trophic level as the functional group members	none
2	1.95	Test organism is in a different order and same trophic level from the functional group members	AV310, AV322, AV333, AV342
3	1.30	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

\*\*B.W from Dunning 1984

\*\*\*Diet consumption from 1500g/pair/month from study

**COPC:** Lead CAS # 7439-92-1  
**Test Organisms:** Rat (Omnivore, Order-Rodentia)  
**Exposure Medium:** Oral in diet as lead acetate  
**Test Endpoint:** LOAEL  
**Reference:** Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of Lead Studies in Animals Carried Out at Haskell Laboratory: Two-Year Feeding Study and Response to Hemorrhage Study", In *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al. (ed.) Commission of European Communities, pp 199-210  
**QCE:** 8 mg/kg-day (100 mg/kg food)\*(0.028 kg/day)/0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	50 male and 50 female rats per dose level. Reproductive three generation (during critical life stage) study.
Q <sub>1</sub>	1	1	1	Mortality, # of tumors, weight gain, # of pregnancies, # of pups born alive, fertility index, gestation index, viability index or lactation index. Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Pb as lead acetate was fed for a three-generation six-litter study at multiple dosages (0, 10, 50, 100, 1000, 2000 ppm). At 1000 and 2000 ppm dietary Pb, the average weight of weanling rats was slightly decreased. At 10 ppm stippled cells were increased. A decrease in ALAD activity was seen at 50 ppm (however these are not considered adverse effects). 100 ppm Pb is considered the NOAEL.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	8	8	8	QCE = quantified critical endpoint
TRV	8	4	2.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8	Test organism is in the same order and trophic level as the functional group members	none
2	4	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*ingestion rate and BW taken from data table for animals

**COPC:** Lead CAS # 7439-92-1  
**Test Organisms:** Beagle Dog (Omnivore, Order-Carnivora)  
**Exposure Medium:** Diet as lead acetate  
**Test Endpoint:** NOAEL  
**Reference:** Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of Lead Studies in Animals Carried Out at Haskell Laboratory: Two-Year Feeding Study and Response to Hemorrhage Study", In *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al. (ed.) Commission of European Communities, pp 199-210

**QCE:** 13 mg/kg-day (500 mg/kg food)\*(0.24kg/day)/9.41 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Four male and four female beagle dogs were used at each dose level (0, 10, 50, 100 and 500 ppm). Two year study. Average variability.
Q <sub>1</sub>	1	1	1	Food consumption, growth, mortality, blood level and behavior. Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	There was no significant effects on appearance, behavior, weight gain, mortality, or neurologic examination of dogs to 500 ppm. A decrease in ALAD activity was seen at 100 ppm. Further study concluded that while ALAD is essential to the synthesis of hemoglobin, the amt. needed is but a small fraction of that normally present and this is not an adverse effect. Lack of reproductive endpoint.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	16	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	3.3	1.6	0.81	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.3	Test organism is in the same order and trophic level as the functional group members	M422A
2	1.6	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.81	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*ingestion rate and BW taken from data table for animals



**COPC:****Lead CAS 7439-92-1****Test Organisms:**

Chicken (Omnivore, (Order-Galliformes))

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Growth

**Reference:**Eisler, R., 1988, *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, Fish and Wildlife Service. Bio. Rep. No. 14. April, 1985**QCE:**

26 mg/kg-day

500 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information. Dietary NOAEL appears consistent for a variety of species.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26	26	26	QCE = quantified critical endpoint
TRV	1.44	0.72	0.48	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.44	Test organism is in the same order and trophic level as the functional group members	none
2	0.72	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.48	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:**

Lead CAS 7439-92-1 Don't use this study

**Test Organisms:**

Cow (Bos spp., Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Diet (in hay and grain)

**Test Endpoint:**

LD50

**Reference:**Zmudski, J., et al., 1983, *Lead Poisoning in Cattle: Reassessment of the Minimum Toxic Oral Dose*, Bull. Environ. Contam. 30:435-441.**QCE:**

2.7 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	22 Holstein males (9-12 weeks old) weighting approx. 55 kg. were tested
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	3	3	3	Lethality endpoint, death w/in 20 d if on milk diet
U	3	3	3	Reasonable design, but no lethality endpoints examined. However, pregnant ewes given 3 mg/kg (species sensitivity could be $\geq$ ) daily did not produce adverse effects (DeMayo, et. al., 1982).
M	1	1	1	Appropriate exposure medium for INEL
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.7	2.7	2.7	QCE = quantified critical endpoint
TRV	0.075	0.038	0.025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.075	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.025	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:****Lead CAS 7439-92-1****Test Organisms:**

Dog (Omnivore, Order: Carnivora)

**Exposure Medium:**

Diet

**Test Endpoint:**

FEL Chronic toxic level

**Reference:**DeMayo, A., et al., 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305Rice, D.C., 1985, *Chronic Low-Lead Exposure from Birth Produces Deficits in Discrimination Reversal in Monkeys*, Toxicol. Appl. Pharmacol. 77:201-210.**QCE:**

0.32 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Tertiary source - cites a textbook
Q <sub>1</sub>	1	1	1	Endpoint not specified
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	3	3	3	FEL endpoint
U	2	2	2	Limited information. However, a chronic study in monkeys reported a similar LOAEL (0.1 mg/kg/day) for CNS effects (Rice, 1985).
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.009	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.006	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

COPC:

Lead CAS 7439-92-1

Test Organisms:

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Drinking Water (Pb as lead acetate)

Test Endpoint:

LOAEL                      Pup malformations

Reference:

Kimmel, C.A., et al., 1980, *Chronic Low Level Lead Toxicity in the Rat. I. Maternal Toxicity and Perinatal Effects*, Toxicol. Appl. Pharmacol. 56:28-41.

QCE:

0.36 mg/kg-day

Specified (5 mg/l in water, rat water intake .025 L/day/0.35 kg BW).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	#'s of animals in control and Pb groups ranged from 60 to 148 during the pregnancy period (2 generations), from 24 to 75 pre-pregnancy, and 6 to 13 litters during post pregnancy. However, significant variation between replicates was seen, and only females (parental generation) examined.
Q <sub>1</sub>	1	1	1	Food % water consumption, reproductive success, and concentrations in selected tissue. Ecologically relevant endpoints.
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL (although Pb concentrations in blood were increased in females exposed to 5 ppm toxicity was not seen at this level)
M	1	1	1	Appropriate exposure medium for INEL
U	1	1	1	Good design, studied reproductive effects. Weanling female rats were exposed through mating, gestation and lactation (offspring then chronically). Various dose levels (0, 5, 25, 50 ppm) studied and LOAEL established. Other studies support findings. (DeMayo et al., 1982).
Total AF	2	4	8	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.36	0.36	0.36	QCE = quantified critical endpoint
TRV	0.18	0.09	0.045	Toxicity Reference Value = QCE/Total AF
R Value	TRV (mg/kg-day)	Justification		Appropriate Functional Group
1	0.18	Test organism is in the same order and trophic level as the functional group members		none
2	0.09	Test organism is in a different order and same trophic level from the functional group members		M422, M422A
3	0.045	Test organism is in a different order and trophic level from the functional group members		M121, M122, M122A, M132, M210, M210A, M222, M322

DeMayo, A., et al., 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305

**COPC:****Lead (Trimethyllead)**, CAS 7439-92-1**Test Organisms:**

European Starling (Insectivore, Order-Passeriformes)

**Exposure Medium:**

Capsule

**Test Endpoint:**

LOAEL

Behavioral effects

**Reference:**Osborn, D., W.J. Eney, and K.R. Bull, 1983, *The toxicity of trialkyl lead compounds to birds*, Environ. Pollut. 31A:261-275. As cited in Eisler (1987)**QCE:**

2.8 mg/kg-day (0.2 mg/day)/0.070 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	6 groups/ group sex not specified
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	2	2	2	FEL endpoint
U	3	3	3	Limited information: organoform of lead could impact toxicity
M	1	1	1	Appropriate exposure medium for INEL
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.8	2.8	2.8	QCE = quantified critical endpoint
TRV	0.08	0.04	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.08	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.03	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:****Magnesium** CAS 7439-95-4**Test Organisms:**

Sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Oral in drinking water

**Test Endpoint:**

NOAEL

**Reference:**

Pierce, A.W. 1959. Studies on salt tolerance of sheep. II. The tolerance of sheep for mixtures of sodium chloride and magnesium chloride in the drinking water. Australian Journal of Agricultural Research, 10:725

**QCE:**

12.7 mg/kg-day \*

700mg/day (0.05% MgCl dose)/55 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	42 ±-6 year old animals tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic exposure (16 months).
Q <sub>3</sub>	2	2	2	NOAEL - loss of weight
U	3	3	3	No reproductive endpoint or sensitive life stage examined. No NOAEL established. Test organisms exposed to MgCl
M	1	1	1	Appropriate exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12.7	12.7	12.7	QCE = quantified critical endpoint
TRV	2.12	1.06	0.71	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.12	Test organism is in the same order and trophic level as the functional group members	none
2	1.06	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.71	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\* Value might need to be checked. NAS book stated 4 for it's LOAEL

\*\*Magnesium intake and BW specified in article

**COPC:** Manganese CAS 7439-96-5

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL Minimum requirement for growth and reproduction

**Reference:** Leeson, S., and J.D. Summers, 1982, *Effect of High Dietary Levels of Supplemental Zinc, Manganese, Copper, or Iron on Broiler Performance to Three Weeks of Age and Accumulation of These Minerals in Tissue and Excreta*, Nutrition Reports Int. 491-599.  
 Offiong, S.A., and S.M. Abed, 1980, *Fertility, Hatchability and Malformations in Guinea Fowl Embryos as Affected by Dietary Manganese*, British Poultry Sci. 21:371-375.

**QCE:** 1262 mg/kg-day (880 mg/kg food)\*(0.717 kg food/day-bird)\*(1 bird/0.5kg)\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals, limited variability
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Acute 13-day study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Only poultry production-type endpoints were evaluated
M	1	1	1	Appropriate exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1262	1262	1262	QCE = quantified critical endpoint
TRV	210.3	105.2	70.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	210.3	Test organism is in the same order and trophic level as the functional group members	none
2	105.2	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	70.1	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*\* Ingestion rate and BW specified in Table II of the Leeson article.

**COPC:****Manganese CAS 7439-96-5****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Decreased testosterone levels, delayed maturation of reproductive function

**Reference:**Laskey, J.W., Rehner, G. L., and Hein, J.F., 1982, *Effects of Chronic Manganese (MN<sub>3</sub>O<sub>4</sub>) Exposure on Selected Reproductive Parameters in Rats*, J. Toxicol. Environ. Health 9: 677-687.ATSDR, Agency for Toxic Substance Disease Registry, 1990, *Draft: Toxicological Profile for Manganese*, 1990.**QCE:**

13 mg/kg-day

350mg/kg food\*0.0138kg/day/0.313kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, males, females and juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Good design, reproductive endpoints examined and the study results consistent in mice.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	13	6.5	4.33	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13	Test organism is in the same order and trophic level as the functional group members	none
2	6.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	4.33	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322



**COPC:****Mercury (Organic)****Test Organisms:**

Cattle (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**

Herigstad, R.R., et al., 1972, "Chronic methylmercury toxicosis in calves." J. Am. Vet. Med. Assoc. 160:173-182. (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC)

**QCE:**

0.1 mg/kg. body weight-day (Hg as methylmercury)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Discussion found that the results were similar to other reported studies. However, limited number of animals, impossible to evaluate variability, only one animal per dose.
Q <sub>1</sub>	1	1	1	Clinical signs, lesions, and tissue residues determined (associated with methyl mercury toxicity (MMT) in calves). Endpoint relevant.
Q <sub>2</sub>	2	2	2	Subchronic exposure (96 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Small number of animals, 5 male Holstein-Friesian calves. No reproductive endpoint or sensitive life stage examined. Test chemical is methylmercury. NOAEL & LOAEL established. However only 1 animal per level tested.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.1	0.1	0.1	QCE = quantified critical endpoint
TRV	0.0056	0.0028	0.0019	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0056	Test organism is in the same order and trophic level as the functional group members	none
2	0.0028	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.0019	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Mercury (Inorganic)  
**Test Organisms:** Japanese quail (Omnivore, Order-Galliformes )  
**Exposure Medium:** Oral in diet  
**Test Endpoint:** NOAEL  
**Reference:** Hill and Shaffner, 1976. *Sexual maturation and productivity of Japanese quail fed graded concentrations of mercuric chloride*. Poultry Science, 55:1449-1459 (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC)  
**QCE:** 0.47 mg/kg-day 4 ppm as mercury chloride in food,  
4 mg/kg\*(0.015kg/day\*\*)/0.13 kg BW\*\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females tested. Experiment 1 used 10 groups of 10 hatchlings of P.W.R.C. Japanese quail, Experiment 2 used 10 groups of 10 hatchlings U.M.D. Japanese quail. Both experiments had comparable results.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint. Reproductive endpoints such as, hatchability, egg size, fertility and egg shell thinning assessed, neurotoxicity not studied.
Q <sub>2</sub>	1	1	1	Chronic exposure (28 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Well designed study. Multiple dose levels (0, 2, 4, 8,16,& 32 ppm) with both NOAELS and LOAELS established. 4 ppm Hg as HgCl <sub>2</sub> , but no neuro.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.47	0.47	0.47	QCE = quantified critical endpoint
TRV	0.47	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.47	Test organism is in the same order and trophic level as the functional group members	none
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Specified as 4 ppm in feed (turkey mash) in study

\*\* Ingestion rate estimated by Nagy (1987) allometric equation,  $0.0582(\text{BW})^{0.651}$

\*\*\*BW estimated by Weimeyer article (0.13 kg)

**COPC:****Mercury (Inorganic)****Test Organisms:**

Chickens (Omnivore, Order-Galliformes)

**Exposure Medium:**

Oral in drinking water

**Test Endpoint:**

NOAEL

**Reference:**

Thaxton, P., L.A. Cogburn, and C.R. Parkhurst, 1973. *Dietary mercury as related to the blood chemistry in young chickens*. Poultry Science 52:1212-1214 (cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC)

**QCE:**

10.1 mg/kg-day

(125mg/L)\*(6.67E-2 L H<sub>2</sub>O/day)/1.2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Results were inconsistent, however a similar study by Parkhurst and Thaxton, 1973 <sup>a</sup> reported toxic effects in young boilers at 250 ppm (similar study) including growth reduction, decreased feed and water efficiencies, alterations in the sizes of certain organs, immunosuppression, & mortality at 250 ppm as LOAEL.
Q <sub>1</sub>	0.5	0.5	0.5	Study determined minor effects of dietary Hg on plasma levels of glucose, total protein, total lipids and other blood chemistry. Endpoint is possible in receptor in the field.
Q <sub>2</sub>	2	2	2	Subchronic exposure (6 weeks)
Q <sub>3</sub>	1	1	1	NOAEL (125 ppm see discussion above)
U	2	2	2	Adequate numbers of test animals, 120 young chickens at each 5 dose levels. Reasonable design. Multiple doses assessed (0, 5, 25, 125, 250 ppm) and NOAEL established but no LOAEL and results were inconsistent. Administered as HgCl <sub>2</sub> in drinking water.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.1	10.1	10.1	QCE = quantified critical endpoint
TRV	2.525	1.263	0.833	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.525	Test organism is in the same order and trophic level as the functional group members	none
2	1.263	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.833	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

Parkhurst, C.R., and P. Thaxton, 1973. *Toxicity of mercury to young chickens. 1. Effect on growth and mortality*. Poultry Science 52:273-276.

**COPC:****Mercury (organic)****Test Organisms:**American black duck (Herbivore, Order-Anseriformes, *Anas rubripes*)**Exposure Medium:**

Oral in diet (mash)

**Test Endpoint:**

Adverse effect - significantly decreased reproduction, elevated tissue levels.

**Reference:**

Finley, M.T. and R.C. Stendell, 1978. "Survival and reproductive success of black ducks fed methylmercury", Environmental Pollution, 16:51-64

**QCE:**0.169 mg/kg-day (3 ppm Hg fed as methylmercury dicyandiamide)  
(3mg/kg food \* 0.062 kg food/day)/(1.1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Variability appears average.
Q <sub>1</sub>	1	1	1	Clutch size, egg production, # of eggs incubated, hatchability and survival of ducklings.
Q <sub>2</sub>	1	1	1	Chronic exposure (28 weeks)
Q <sub>3</sub>	3	3	3	Adverse effect level (reduced reproduction success)
U	3	3	3	No NOAEL established and only 1 dose level and control. 13 pairs of 1 year old ducks in each group, juveniles also tested.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.169	0.169	0.169	QCE = quantified critical endpoint
TRV	0.0094	0.0047	0.0031	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0094	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.0047	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.0031	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

BW is taken as the mean for females (1.1 kg) from the CRC Handbook of Avian Body Masses (Dunning, 1993)  
allometric equations from Nagy (1987)  $FI = 0.648 BW^{0.631} = 0.062 \text{ kg/day}$

**COPC:****Mercury (Organic)****Test Organisms:**Mallard Duck (Herbivore, Order-Anseriformes, *Anas platyrhynchos*)**Exposure Medium:**

Oral in diet

**Test Endpoint:**

reproduction

**Reference:**

Heinz, G. H. 1979. Methyl mercury: reproductive and behavioral effects on three generations of mallard ducks. J. Wildl. Mgmt. 43:394-401.

**QCE:**0.064 mg/kg-day 0.5 ppm Hg as methylmercury dicyandiamide in food  
(0.5 mg Hg/kg food \* 0.128 kg food/day)/ 1 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only one dose level, however, this was a three generation study that showed significant effects from control.
Q <sub>1</sub>	1	1	1	Endpoints include reproductive endpoints (i.e. # of eggs and hatchlings). Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	2	2	2	LOAEL - one dose only
U	2	2	2	3 generations >1 yr and during a critical lifestage) and reproductive endpoints examined. However, only 1 dose considered.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.064	0.064	0.064	QCE = quantified critical endpoint
TRV	0.008	0.004	0.0027	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.008	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.004	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.0027	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:****Mercury (Organic)****Test Organisms:**

Pheasants (Omnivore, Order-Galliformes)

**Exposure Medium:**

gelatin capsule

**Test Endpoint:**

AEL - decreased reproductive ability

**Reference:**

McEwen, L.C., et al., 1973. "Mercury-Wildlife Studies by the Denver Wildlife Research Center", In *Mercury in the Western Environment*, D.R. Buhler, Ed., Oregon State University, Corvallis, OR, p. 146-156

**QCE:**

0.64 mg/kg-day

20 mg/kg Ceresan M<sup>R</sup> (mercury fungicide) the 0.64 mg/kg-day was specified by article for a 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No: a large sample, three male and female pheasant pairs.
Q <sub>1</sub>	1	1	1	Endpoints included the # of eggs laid, fertile, hatched and alive chicks. Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic exposure (30 days)
Q <sub>3</sub>	3	3	3	Adverse effect level
U	3	3	3	Only 1 dosage and control in a pesticide formulation, small number of samples, and NOAEL not established. Author mentions that the capsule dosage is lower than what a wild bird would be estimated to ingest feeding on seeds.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	54	108	162	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.0119	0.0059	0.0040	Toxicity Reference Value = QCE/Total AF

**Appropriate Functional Groups:**

M	1	1	1	Soluble
1	0.0119	Test organism is in the same order and trophic level as the functional group members	none	
2	0.0059	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442	
3	0.0040	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342	

**COPC:****Mercury (Organic)****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral in drinking water

**Test Endpoint:**

NOAEL

**Reference:**Schroeder and Mitchener, 1975. "Life-term effects of mercury, methylmercury and nine other trace metals on mice" *J. Nutr.* 105:452**QCE:**

0.14 mg/kg-day

Calculated, 1 ppm Hg as methylmercury acetate \*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. 5 ppm Hg as methylmercury acetate for 70 days and 1 ppm subsequently in the drinking water. 5 ppm was toxic but 1 ppm appears to have beneficial effects, with the mice that survived gaining weight and living longer than littermates given 1 ppm from time of weaning.
Q <sub>1</sub>	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevity.
Q <sub>2</sub>	1	1	1	Lifetime exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Average study design with limited number of doses, and no reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. Both a NOAEL and LOAEL established.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.03	0.02	0.01	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.03	Test organism is in the same order and trophic level as the functional group members	none
2	0.02	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.01	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

$$*[(1 \text{ mg Hg}_2/\text{L}) * (0.0051 \text{ L water/day}^{**}) / 0.0373 \text{ kg BW}] = 0.14 \text{ mg/kg BW-day}$$

\*\*Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA 1993)  
 $WI = 0.099 BW^{0.9}$

**COPC:** Mercury (Inorganic)

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** NOAEL

**Reference:** Schroeder and Mitchener, 1975. "Life-term effects of mercury, methylmercury and nine other trace metals on mice" *J. Nutr.* 105:452

**QCE:** 0.68 mg/kg-day      Calculated 5 ppm Hg as mercuric chloride\*.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. At 5 ppm longevity tended to decrease in males and increase in females.
Q <sub>1</sub>	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevity
Q <sub>2</sub>	1	1	1	Life time exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. 5 ppm Hg as mercuric chloride in the basal drinking water. Only one dose tested and no LOAEL established.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.68	0.68	0.68	QCE = quantified critical endpoint
TRV	0.17	0.09	0.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.17	Test organism is in the same order and trophic level as the functional group members	none
2	0.09	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.06	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*  $[(5 \text{ mg Hg}_2/\text{L water}) * (0.0051 \text{ L water/day})] / 0.0373 \text{ kg BW}$

Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA 1993)

$WI = 0.099BW^{0.9}$



**COPC:****Mercury (Organic)****Test Organisms:**

Swine (Omnivore, Order-Artiodactyla)

**Exposure Medium:**Oral in diet (organic form methylmercuric chloride  $\text{CH}_3\text{HgCl}$ )**Test Endpoint:**

NOAEL

**Reference:**

Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977. "Effect of varied dietary levels and forms of mercury on swine" J. Anim. Sci. 45:279-285.

**QCE:**

0.025 mg/kg-day

specified 0.5 ppm  $[(0.5 \text{ mg/kg}) \times (2.5 \text{ kg/day}) / 50 \text{ kg}]$ **BW\***

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at .5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated feed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
$Q_1$	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
$Q_2$	2	2	2	Subchronic exposure (exposure thru breeding and birthing, however estimated at less than 50% of the total lifespan of a pig)
$Q_3$	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoint examined. LOAEL was established, however, different between NOAEL and LOAEL levels is great.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.025	0.025	0.025	QCE = quantified critical endpoint
TRV	0.0063	0.0031	0.0021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0063	Test organism is in the same order and trophic level as the functional group members	None
2	0.0031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate from allometric equation, BW from study.

**COPC:****Mercury (Inorganic)****Test Organisms:**

Swine (Omnivore, Order-Artiodactyla)

**Exposure Medium:**Oral in diet (as mercuric chloride-HgCl<sub>2</sub>)**Test Endpoint:**

reproductive (NOAEL established)

**Reference:**

Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977. "Effect of varied dietary levels and forms of mercury on swine" J. Anim. Sci. 45:279-285.

**QCE:**0.25 mg/kg-day (HgCl<sub>2</sub>) specified 5 ppm (5 mg/kg)x(2.5kg/day)/50 kg BW\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at .5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated feed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
Q <sub>1</sub>	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
Q <sub>2</sub>	2	2	2	Subchronic exposure (exposure thru breeding and birthing, however estimated at less than 50% of the total lifespan of a pig)
Q <sub>3</sub>	1	1	1	NOAEL
M	1	1	1	Appropriate exposure medium for INEL
U	1	1	1	Good design, reproductive endpoint examined, however no LOAEL established.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.25	0.25	0.25	QCE = quantified critical endpoint
TRV	0.063	0.031	0.021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.063	Test organism is in the same order and trophic level as the functional group members	None
2	0.031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate from allometric equation, BW from study

**COPC:****Mercury (Organic) CAS 7439-97-56****Test Organisms:**

Cat (Carnivore, Order-Carnivora)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**Charbonneau, S.M., et al., 1976. *Chronic Toxicity of Methylmercury in the Adult Cat*, Interim Report, *Toxicology*, 5(1976):337-349.**QCE:**

0.02 mg/kg-day

Specified -either in naturally contaminated fish (methylmercury) or added to diet as methylmercuric choride.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Each test group consisted of 8 random-bred domestic cats, 4 males and 4 females. Not rigorously examined, but no large variations within groups were evident
Q <sub>1</sub>	1	1	1	Food consumption, body weight, blood and urine changes and neurological status were examined. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Doses of 3, 8.4, 20, 46, 74 or 176 µg Hg/kg/day both in fish and as corn oil supplement. Older study, but thoroughly performed. Dose-response well-characterized for neurological effects, but reproductive effects not considered.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.02	.02	.02	QCE = quantified critical endpoint
TRV	0.005	0.0025	0.0017	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.005	Test organism is in the same order and trophic level as the functional group members	M322
2	.0025	Test organism is in a different order and same trophic level from the functional group members	M422A
3	.0017	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M422

**COPC:****Mercury (Organic) CAS 7439-97-56****Test Organisms:****Mule Deer (Herbivore, Order-Artiodactyla)****Exposure Medium:****Single dose****Test Endpoint:****FEL-1 (LD-50)****Reference:****Eisler, R., 1987, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report, 85(1.10).****QCE:****18 mg/kg-day**

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	LD-50
U	3	3	3	Secondary source, little supporting information
M	1	1	1	Appropriate exposure medium for INEL
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	18	18	18	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.07	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:****Mercury (Organic) CAS 7439-97-56****Test Organisms:**

Mink (Carnivore, Order-Carnivora)

**Exposure Medium:**

Oral in diet as methyl mercury chloride

**Test Endpoint:**

NOAEL

**Reference:**

Wobeser, G., N.O. Nielson, and B. Schiefer. 1976. "Mercury and mink II. Experimental methyl mercury intoxication." Can. J. Comp. Med. 34-45,

**QCE:**

0.15 mg/kg-day (1.1 mg Hg/kg food \* 0.137 kg food /day)/(1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Five adult female mink per trt group were sampled at 1.1, 1.8, 4.8, 8.3 and 15 ppm Hg in diet. Study for 93 days and not during a critical lifestage.
Q <sub>1</sub>	1	1	1	Mortality, weight loss and ataxia. Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic study, 93 days
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Mercury doses of 1.8 ppm or greater produced significant adverse effects as a LOAEL. Mercury levels in tissue were evident at 1.1 ppm however, no significant effects observed. However, endpoint not based on reproduction.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.15	0.15	0.15	QCE = quantified critical endpoint
TRV	0.019	0.0094	0.0063	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.019	Test organism is in the same order and trophic level as the functional group members	none
2	0.0094	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.0063	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:****Mercury (Organic)** CAS 7439-97-56**Test Organisms:**

Pheasant (Omnivore, Order-Galliformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

LOAEL-r

Reduced egg production, shell thickness, reduced hatchability

**Reference:**Fimreite, N., 1979, *Accumulation and Effects of Mercury on Birds*, Chapter 22 in *The biogeochemistry of Mercury in the Environment*, J.O. Nriagu, (ed.), Elsevier/North Holland Biomedical Press, New York.**QCE:**

.18 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information, cited in EPA, 1993, Wildlife Exposure Factors Handbook
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration (12 weeks)
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Old study, secondary source, no NOAEL identified
M	1	1	1	Appropriate exposure medium for INEL
Total AF	24	48	72	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.18	.18	.18	QCE = quantified critical endpoint
TRV	.0075	.0038	.0025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.0075	Test organism is in the same order and trophic level as the functional group members	none
2	.0038	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	.0025	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Mercury (Organic) CAS 7439-97-56****Test Organisms:**

Rat (Omnivore, Order - Rodentia)

**Exposure Medium:**

Oral (methylmercuric chloride in diet)

**Test Endpoint:**

LOAEL

No effects on dams or offspring of female rats treated with methylmercury from weaning through parturition

**Reference:**Khera and Tabacova, 1973, *Effects of Methylmercuric Chloride on the Progeny of Mice and Rats Treated Before or During Gestation*, Food and Cosmetic Toxicology, 11:245-254.**QCE:**

0.05 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No prenatal effects were seen at 0.25 mg/kg-day however, an increased incidence of eye defects was seen. The study suggests that mercury was a contributory factor, in some unexplained way. This paper provides documentation of studies providing similar results.
Q <sub>1</sub>	1	1	1	Reproductive success measured, by # of pregnant mice, # of young per litter, weight of young, and postnatal survival. Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Subchronic duration
Q <sub>3</sub>	1	1	1	LOAEL
U	1	1	1	Immature females of the Wistar strain were randomized into 5 groups each consisting of 35 rats. Doses included 0, 0.002, 0.01, 0.05, or 0.25 mg Hg/kg/day as CH <sub>3</sub> HgCl. The exposure was continued for sub-groups up to 192 days. Highest dose level was NOAEL for sensitive and relevant endpoint and LOAEL was not established.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.05	0.05	0.05	QCE = quantified critical endpoint
TRV	0.025	0.0125	0.0083	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.025	Test organism is in the same order and trophic level as the functional group members	none
2	0.0125	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0083	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Mercury (Organic) CAS 7439-97-56****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**Verschuuren, H.G., et al., 1976, *Toxicity of methyl mercury chloride in rats. II. Reproduction study* Toxicol. 6:97-106.**QCE:**

0.025 mg/kg-day                      Calculated

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	3 generation (> 1 yr and during a critical lifestage = chronic)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint reproduction
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	
M	1	1	1	Appropriate exposure medium for INEL
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.025	0.025	0.025	QCE = quantified critical endpoint
TRV	0.025	0.0125	0.0083	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.025	Test organism is in the same order and trophic level as the functional group members	none
2	0.0125	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0083	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322



**COPC:****Nickel CAS 7440-02-1)****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Growth

**Reference:**Weber, C.W., and Reid, B.L., 1968, *Nickel toxicity in growing chicks*, J. Nutr. 95:612-616.**QCE:**

37 mg/kg-day

500 ppm in diet converted to a dose using an estimated ingestion rate\* of 0.037 kg/day and a body weight of 500 g from the study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Sub:chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Production parameters
Q <sub>2</sub>	2	2	2	Sub:chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Older study, reproductive endpoints not evaluated
M	1	1	1	Appropriate exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	37	37	37	QCE = quantified critical endpoint
TRV	6.17	3.08	2.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.17	Test organism is in the same order and trophic level as the functional group members	none
2	3.08	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.06	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Estimated as  $0.0582 \text{ Wt}^{0.651}$  (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

**COPC:** Nickel CAS 7440-02-0  
(nickel carbonate)

**Test Organisms:** Cow (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL No effect on food intake or growth rate

**Reference:** O'Dell et al., 1970a, "Effect of Nickel Supplementation on the Production and composition of Milk, *J. Dairy Science*. National Academy of Sciences, 1980, *Mineral Tolerance of Domestic Animals*, Washington, DC

**QCE:** 4.1 mg/kg-day 1835mg/day/450 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information or supporting studies.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	0.23	0.11	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.08	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\*BW an estimate until get actual article

\*\*Other O'Dell articles may be more helpful, check the NAS book.

**COPC:**

Nickel CAS 7440-02-0

**Test Organisms:**

Dog (Omnivore, Order-Carnivora)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Treatments had no effect on body weight gain

**Reference:**Ambrose, A.M. et al. 1976, *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs*, J. Food Sci. Technol. 13:181-187.**QCE:**

25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Limited information or supporting studies.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	12.50	6.25	4.17	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	12.50	Test organism is in the same order and trophic level as the functional group members	M422A
2	6.25	Test organism is in a different order and same trophic level from the functional group members	M422
3	4.17	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:**

Nickel CAS 7440-(2-0

**Test Organisms:**

Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Egg production, hatchability, duckling survival;  
hematological parameters**Reference:**Eastin, W.C., Jr. and O'Shea, T.J., 1981, *Effects of Dietary Nickel on Mallards*, J. Toxicol. Environ. Health 7(6):883-892.White, D.H., and M.P. Dieter, 1978, *Effects of Dietary Vanadium in Mallard Ducks*, Journal of Toxicol. and Environ. Health, 4:43-50.**QCE:**

140 mg/kg-day

(800mg/kg food)\*(0.205mg/day\*)/1.17 kg BW \*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic toxicity study; variability not addressed
Q <sub>1</sub>	1	1	1	No effect observed, ecol. relevant examined
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Reproductive endpoints evaluated, no LOAEL identified.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	140	140	140	QCE = quantified critical endpoint
TRV	17.50	8.75	5.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.50	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	8.75	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	5.83	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

\*Birds on 800ppm diet ate 15% more food than the 178g/day of the controls = 205g

\*\*Body weight is indicated in the 1978 White and Dieter study.

**COPC:** Nickel CAS 7440-02-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Treatments had no effect on body weight gain  
 Ambrose, A.M., et al., 1976 *Long-Term Toxicologic Assessment of Nickel in Rats and Dogs*, *J. Food Sci. Technol.* 13:181-187.  
 ABC (American Biogenics Corp.), 1986, *Ninety-Day Gavage Study in Albino Rats Using Nickel*, Draft Final Report submitted to Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709.  
 RTI (Research Triangle Institute), 1987, *Two Generation Reproduction and Fertility Study of Nickel Chloride Administered to CD Rats in Drinking Water: Fertility and Reproductive Performance of the Po Generation (Part II of III) and F1 Generation (Part I of III)*, Final study report, Report submitted to Office of Solid Waste Management, U.S. EPA, Washington, DC.

**QCE:** 5 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic: toxicity study with adequate numbers of animals.
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic: study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Low survival in controls; however, another study by ABC, 1986 supports the 5 mg/kg/day NOAEL. A NOAEL for reproductive effects in a study by RTI (1987) was higher than the Ambrose study.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5	5	5	QCE = quantified critical endpoint
TRV	2.50	1.25	0.83	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.50	Test organism is in the same order and trophic level as the functional group members	none
2	1.25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****PCBs (Aroclor 1260) CAS 1336-36-3****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet in chow

**Test Endpoint:**

NOAEL

**Reference:**Linder, R.E., T.B. Caines, and R.D. Kimbrough, 1974, *The Effect of Polychlorinated Biphenyls on Rat Reproduction*, Food and Cosmetic Toxicology, 12:63-77.**QCE:**

7.4 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response (10 males and 20 females)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint: viability counts of offspring, body weights, livers, weights of spleen, heart, lungs, brain, kidneys, testes.
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study, testing different doses (0,5,20,100ppm). Started on diets at 3-4 weeks of age, doses continued through mating, gestation, and lactation. No LOAEL established.
M	1	1	1	Not applicable
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.4	7.4	7.4	QCE = quantified critical endpoint
TRV	7.40	3.70	2.47	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.40	Test organism is in the same order and trophic level as the functional group members	none
2	3.70	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.47	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Selenium (Sodium selenite) CAS 7782-49-2  
**Test Organisms:** Chicken (Omnivore, Order-Galliformes)  
**Exposure Medium:** Diet  
**Test Endpoint:** NOAEL Egg hatchability  
**Reference:** Ort, J.F. and J.D. Latshaw, 1978, "The toxic level of sodium selenite in the diet of laying chickens," Journal of Nutrition, 108:1114-1120.  
 EPA, 1993, Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005.

Eisler, R. 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).

**QCE:** 0.198 mg/kg-day (3mg/kg)\*(0.132kg/hen-day\*\*)/2kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested (100 female birds) and results are consistent with other studies in chickens and quail
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant: egg production, egg weight and fertility, hatchability
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	NOAEL endpoint
U	2	2	2	Older study but good design, however only females were tested
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R \cdot I \cdot Q_1 \cdot Q_2 \cdot Q_3 \cdot U = \text{Total AF}$
QCE (mg/kg-day)	0.198	0.198	0.198	QCE = quantified critical endpoint
TRV	0.0495	0.0248	0.0165	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0495	Test organism is in the same order and trophic level as the functional group members	none
2	0.0248	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.0165	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*\*Ingestion rate specified in table 2 page 1116 of article

**COPC:** Selenium (Sodium selenite) CAS 7782-49-2  
**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)  
**Exposure Medium:** Diet  
**Test Endpoint:** NOAEL Egg hatchability  
**Reference:** Heinz, G.H. et al. 1987, "Reproduction in mallards fed selenium," Environmental Toxicology and Chemistry, 6:423-433.  
 Eisler, R. 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).  
 EPA. 1993, Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005.

**QCE:** 0.5 mg/kg-day (5 mg/kg \* 0.1 kg feed)/ 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 pairs for five doses tested, study results consistent with other studies in chickens and quail, repro/devel. toxicity analysis only.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic study (2-4 mos.)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
M	1	1	1	Appropriate exposure medium for INEL
U	1	1	1	Reproductive study only with different forms of selenium
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.5	0.5	0.5	QCE = quantified critical endpoint
TRV	0.25	0.13	0.083	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.083	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442



**COPC:****Selenium CAS 7782-49-2****Test Organisms:**

Rat (Omnivore, Order: Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Reproduction, number of young reared

**Reference:**Rosenfeld, I. and O.A. Beath. 1954. Effect of selenium on reproduction in rats. Proc. Soc. Exp. Biol. Med. 87:295-297.**QCE:**

0.075 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Older study, but analyzed 5 breeding cycles and 2 generations. A more recent study by Nobunaga et al. (1979) reports a NOAEL of 390 ug/kg/day selenite for mice reproductive success.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	1	2	3	$R * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.075	0.075	0.075	QCE = quantified critical endpoint
TRV	0.075	0.038	0.025	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.075	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.025	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

COPC:	Selenium CAS 778?-49-2
Test Organisms:	Mouse (Omnivore, Order-Rodentia)
Exposure Medium:	Oral in water
Test Endpoint:	FEL                      Reproduction, number of young reared
Reference:	Schroeder and Mitchner 1971. Toxic effects of trace elements on the reproduction of mice and rats. <i>Arch. Environ. Health.</i> 23: 102-106.
QCE:	0.76 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of females (104) tested, no males or juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study (3 generations)
Q <sub>3</sub>	3	3	3	FEL endpoint (only one dose examined)
U	2	2	2	Good design, only reproductive endpoints (fetus) examined.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.76	0.76	0.76	QCE = quantified critical endpoint
TRV	0.063	0.032	0.021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.063	Test organism is in the same order and trophic level as the functional group members	none
2	0.032	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*ingestion rate and BW specified in article

**COPC:****Selenium CAS 7782-49-2****Test Organisms:**

Black-crowned Night Heron

**Exposure Medium:**

Diet

**Test Endpoint:**

LOAEL

**Reference:**Smith, G.J., et al., 1984, "Reproduction in Black-Crowned Night-Herons Fed Selenium." *Lake and Reservoir Mgmt.* 4(2):175-180**QCE:**

2.5 mg/kg-day

10 mg/kg in diet converted to dose by multiplying by  
0.212 kg/day ingestion rate and dividing by 0.85 kg  
BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males and females tested (12 pairs), study results consistent with other studies in chickens and quails.
Q <sub>1</sub>	1	1	1	Hatching success, organ weights, blood measures, eggshell thickness, however 3-day-old hatchlings had shorter femurs and radius ulna legs and other hemotological effects.
Q <sub>2</sub>	2	2	2	Subchronic study, lasted only 3 mos.
Q <sub>3</sub>	2	2	2	LOAEL.
M	1	1	1	Appropriate exposure medium for INEL
U	2	2	2	No NOAEL established. Reproductive endpoints examined.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.5	2.5	2.5	QCE = quantified critical endpoint
TRV	0.156	0.078	0.052	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.156	Test organism is in the same order and trophic level as the functional group members	none
2	0.078	Test organism is in a different order and same trophic level from the functional group members	AV310, AV322, AV322A, AV333, AV342
3	0.052	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222AAV232, AV233, AV241, AV242, AV432, AV432A, AV442

**COPC:****Selenium CAS 7782-49-2 Don't Use****Test Organisms:**

Sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Diet

**Test Endpoint:**

FEL

Mortality

**Reference:**

Eisler, R. 1985, Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).

**QCE:**

3.2 mg/kg-day

Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	Lethal endpoint
U	3	3	3	Secondary source
M	1	1	1	Appropriate exposure medium for INEL
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.2	3.2	3.2	QCE = quantified critical endpoint
TRV	.04	.02	.013	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	.04	Test organism is in the same order and trophic level as the functional group members	none
2	.02	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	.013	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:**

Silver CAS 7440-22-4

**Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:**

Drinking Water

**Test Endpoint:**

FEL-n

**Reference:**

Rungby and Danscher. 1984. "Hypoactivity in silver exposed mice," Acta Pharmacol and Toxicol, 55(5):398-401.

**QCE:**

3 mg/kg-day (0.09 mg/0.03 kg)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Females; only for the long-term study
Q <sub>1</sub>	0.1	0.1	0.1	Not clearly relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Only one dose, no NOAEL identified.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2.4	4.8	7.2	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3	3	3	QCE = quantified critical endpoint
TRV	1.25	0.625	0.417	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.25	Test organism is in the same order and trophic level as the functional group members	none
2	0.625	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.417	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Sodium CAS 7440-23-5 Don't use, injection

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Intraperitoneal injection

**Test Endpoint:** LD<sub>50</sub>

**Reference:** *Acta Pharmacol. Toxicol.*, 52:80, 1983; *Hazardous Substance Database*, (HSDB), Online computer database, 1995.

**QCE:** 4,000 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Duration of exposure unknown (probably acute)
Q <sub>3</sub>	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	40.5	81.0	121.5	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4,000	4,000	4,000	QCE = quantified critical endpoint
TRV	98.8	49.4	32.9	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	98.8	Test organism is in the same order and trophic level as the functional group members	none
2	49.4	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	32.9	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Sulfate Secondary source

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>90</sub>

**Reference:** Venugopal, B. and T.D. Luckey, 1978. *The Toxicity of Metals in Mammals*, New York, Plenum Press

**QCE:** 1,292 mg/kg-day (from potassium sulfate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1292	1292	1292	QCE = quantified critical endpoint
TRV	16.0	8.0	5.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	16.0	Test organism is in the same order and trophic level as the functional group members	none
2	8.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Sulfate****Test Organisms:**

Turkeys (Omnivore, Order-Galliformes)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**

Cakir, A., T.W. Sullivan, and F.B. Mather, 1978. Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum. Poultry Science 57:498, as cited in National Academy of Sciences, 1980. Mineral Tolerance of Domestic Animals. Washington, DC

**QCE:**

207.4 mg/kg-day (from aluminum sulfate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (28 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al <sub>2</sub> (SO <sub>4</sub> )·18H <sub>2</sub> O
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	207.4	207.4	207.4	QCE = quantified critical endpoint
TRV	25.9	13.0	8.6	Toxicity Reference Value = QCE/Total AF
Appropriate Functional Groups:				
R Value	TRV (mg/kg-day)	Justification		Appropriate Functional Group
1	25.9	Test organism is in the same order and trophic level as the functional group members		none
2	13.0	Test organism is in a different order and same trophic level from the functional group members		AV422, AV432, AV433, AV442
3	8.6	Test organism is in a different order and trophic level from the functional group members		AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342



COPC:

Thallium CAS 7440-28-0

Do not use if possible

Test Organisms:

Quail (Omnivore, Order-Galliformes)

Exposure Medium:

Bread

Test Endpoint:

FEL-1

Death

Reference:

Shaw, P.A., 1933, "Toxicity and deposition of thallium in certain game birds,"  
Journal of Pharmacology and Experimental Therapeutics, 48(4):478-487

QCE:

12 mg/kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is: AF for same order and trophic level R = 2 is: AF for different order and same trophic level R = 3 is: AF for different order and trophic level
I	3	3	3	Very old study, doses and effects poorly characterized, only high doses and lethal endpoints considered
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Acute duration
Q <sub>3</sub>	3	3	3	FEL for lethality
U	3	3	3	Very old study, poorly designed and analyzed
M	1	1	1	Appropriate exposure medium for INEL
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	0.148	0.074	0.049	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.148	Test organism is in the same order and trophic level as the functional group members	none
2	0.074	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.049	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Ingestion rate from Wildlife Exposure Factors Handbook and BW from Weimeyer article

\*\*note-in the article the units on the 12 were just mg/kg...it was assumed that that meant kg of food.

**COPC:****Thallium CAS 7440-28-0****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral in Diet

**Test Endpoint:**

LOAEL Hair loss

**Reference:**Downs, W., Scott, J., Steadman, L., Maynard, E., 1960, "Acute and Sub-acute Toxicity Studies of Thallium Compounds", *Industrial Hygiene Journal*, pp399-406**QCE:**

1.8mg/kg-day

Specified (Average between 1-3 depending on the BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and female rats tested, no juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Good design, a variety of compounds tested, reproductive endpoints not examined. Compound is thallium acetate. Similar responsiveness for thallium oxide.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

  

Error! Book mark not defined.R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:****Thallium** CAS 7440-28-0**Test Organisms:**

Rat (Omnivore, Order Rodentia)

**Exposure Medium:**

Drinking Water

**Test Endpoint:**

FEL-r

Reduced sperm motility, etc.

**Reference:**Formigli, L., et al., 1986, "Thallium-induced testicular toxicity in the rat,"  
Environmental Research, 40(2):531-539.**QCE:**

.75mg/kg-day

Daily intake of 0.27 mg/rat, each rat weighing an ave.  
of 0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well characterized effects, consistent results among groups, only male reproduction toxicity was evaluated.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	3	3	3	FEL based on reproductive effects
U	2	2	2	Only one dose, no NOAEL identified
M	1	1	1	Appropriate exposure medium for INEL
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	.75	.75	.75	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Vanadium (Ammonium metavanadate) (CAS 7440-6202)

**Test Organisms:** Cow (calves)

**Exposure Medium:** Gelatin capsule

**Test Endpoint:** NOAEL Clinical symptoms

**Reference:** Platonow, N. and H.K. Abbey, 1968, "Toxicity of Vanadium in Calves". *Vet. Record*, 82:292.

**QCE:** 7.5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 young males
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Older study, reproductive and sensitive endpoints not evaluated.
V				
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.5	7.5	7.5	QCE = quantified critical endpoint
TRV	0.94	0.47	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.94	Test organism is in the same order and trophic level as the functional group members	none
2	0.47	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:****Vanadium (Vanadyl sulfate) CAS 27774-13-6(sulfate)****Test Organisms:**

Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

Growth and egg production

**Reference:**Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," Poultry Science, 62:47-50.**QCE:**

1.7 mg/kg-day

25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Multiple doses evaluated, good statistical analysis of data, but only weight and egg production were evaluated.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R \times I \times Q_1 \times Q_2 \times Q_3 \times U = \text{Total AF}$
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.425	0.213	0.142	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.425	Test organism is in the same order and trophic level as the functional group members	none
2	0.213	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.142	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*\*FI=0.0582(BW)<sup>0.651</sup> cited in EPA Wildlife Exposures Handbook

**COPC:** Vanadium (Vanadyl sulfate) CAS 7440-62-2  
**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)  
**Exposure Medium:** Diet  
**Test Endpoint:** NOAEL Altered lipid metabolism  
**Reference:** White, D.H. and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks. Journal of Toxicology and Environmental Health.  
**QCE:** 1.0 mg/kg-day 10 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic study with adequate numbers of animals
Q <sub>1</sub>	0.5	0.5	0.5	Ecological relevance of endpoint questionable
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, multiple doses evaluated
M	1	1	1	Appropriate exposure medium for INEL
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:****Vanadium (Vanadyl sulfate) CAS 7440-62-2****Test Organisms:**

Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL Body weight gain

**Reference:**Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," Journal of Nutrition, 92:245-252.

ATSDR. Agency for Toxic Substance Disease Registry. 1990. Draft: Toxicological Profile for Vanadium. October, 1990.

**QCE:**

4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Zinc (zinc sulfate) CAS 68813-94-5 (basic)

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL Decreased egg production

**Reference:** Stahl, J.L., Greger, J.L., and M.E. Cook, 1990, "Breeding hen and progeny when hens are fed excessive dietary zinc," Poultry Science, 69:259-263.  
Hoadley, J.E., S.H. Tao, and M.R. W. Fox, 1989, "Dietary cadmium and zinc effects on peripheral neuromuscular development," 73rd Annual Meeting of the Federation of American Societies for Experimental Biology, New Orleans, LA., March 19-23, 1989, Federation of American Society for Experimental Biology, 4929.

**QCE:** 12 mg/kg-day 20 mg/kg in diet converted to dose by 0.105 kg/day ingestion (from study) and 0.172 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate number of animals
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	High quality study
M	1	1	1	Appropriate exposure medium for INEL
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	6.00	3.00	2.00	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.00	Test organism is in the same order and trophic level as the functional group members	none
2	3.00	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.00	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342



**COPC:****Zinc CAS 7440-66-6****Test Organisms:**

Ferret (Carnivore, Order-Carnivora)

**Exposure Medium:**

Diet

**Test Endpoint:**

Weight gain, anemia/kidney effects

**Reference:**Straube, E.F., Schuster, N.H., and Sinclair, A.J., 1980, "Zinc toxicity in the ferret," Journal of Comparative Pathology, 90:355-361.**QCE:**

142 mg/kg-day

500mg/kg\*0.170kg/day/0.60kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	NOAEL group was only 3 animals
Q <sub>1</sub>	1	1	1	Overall health, weight gain, haematological measurements, levels of zinc in organs
Q <sub>2</sub>	2	2	2	Subchronic duration (48, 138 and 191 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Adequate study design, but no reproductive endpoints examined.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	142	142	142	QCE = quantified critical endpoint
TRV	35.5	17.75	11.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	35.5	Test organism is in the same order and trophic level as the functional group members	M322
2	17.75	Test organism is in a different order and same trophic level from the functional group members	none
3	11.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** Zinc CAS 68813-04-5 (basic)  
**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)  
**Exposure Medium:** Diet  
**Test Endpoint:** LOAEL Mortality, BW, and blood chemistry  
**Reference:** Gasaway and Buss, 1972, "Zinc Toxicity in the Mallard Duck", *J. Wildl. Manage.*, 36:1107-1117  
**QCE:** 207 mg/kg-day (3000mg/kg food)\*(0.0363kg/day)/(0.525 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	15 males and 15 females tested, no juveniles
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	High quality study, but no NOAEL dose was found, all doses were toxic
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	207	207	207	QCE = quantified critical endpoint
TRV	25.88	12.94	8.63	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25.88	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	12.94	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	8.63	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

\*Ingestion rate specified in article, converted to ounces/10 days to kg/day

\*\*BW estimated by interpolation of values given in the Wildlife Exposures Handbook and an average of 77% weight loss(given in article).  $682 * 0.77 = 525$  g

COPC:

Zinc (zinc oxide) CAS 7440-66-6

Test Organisms:

Rat (Omnivore, Order-Rodentia)

Exposure Medium:

Diet

Test Endpoint:

LOAEL Developmental effects

Reference:

Schlicker, S.A. and D.H. Cox, 1968, "Maternal dietary zinc and development and zinc, iron and copper content of the rat fetus," Journal of Nutrition, 95:287-294.  
 ATSDR, Agency for Toxic Substance Disease Registry, 1988, Draft:  
 Toxicological Profile for Zinc, December.

QCE:

100mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number (60) of females tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration (36 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Good design, reproductive endpoints and sensitive life stage examined, only 2 doses tested.
M	1	1	1	Appropriate exposure medium for INEL
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	12.50	6.25	4.17	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	12.50	Test organism is in the same order and trophic level as the functional group members	none
2	6.25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	4.17	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322